Langmuir Probe experiments for the Ice Giants: Concepts for exploration of Uranus and Neptune systems

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Abstract

We present instrument concepts for Langmuir Probe experiments on future missions to the Ice Giant systems, including both orbiters and descent probes, and discuss the measurement goals of such experiments.

With heritage from Cassini, Rosetta, other solar system missions, and experience from JUICE development, we also discus the versatility of these experiments - playing important roles in characterising plasma properties in dense ionospheres, plasma dominated moon-magnetosphere interactions, cometary comae and other space environments.

In the case of Cassini, measurements made by the Langmuir Probe technique have been critical in understanding the complex roles played by charged dust in the interactions between the planet's ionosphere, satellites, and ring systems, as well as the more general structure and dynamics of the plasmas in these systems.

Unexpected similarities in the ionosphere's of Titan and Saturn point to the important roles played by ionospheric (plasma) chemistry in forming the precursors to haze layers in both systems.

Applied specifically to the Ice Giant atmospheres, the scientific usefulness of such instrumentation lies in the study of the structure of the ionosphere, and interactions between the ionosphere, neutral atmosphere, tenuous ring systems, and magnetospheric plasma populations.

Fundamentally, Langmuir Probes provide measurements of ambient bulk electron density and temperature, and spacecraft potential, derived from current-voltage sweeps.

Additional measurements of ion and dust charge densities are also possible, along with higher temporal resolution operations.

Various instrument configurations are discussed, including the possibility of a dual-probe experiment also able to measure low frequency electric fields.

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